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Strain Profiles in BST Films
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Beamline(s): X22C

Introduction: (BaSr)TiO3 (BST) films are being considered as candidates for ferroelectric memory storage applications. The detailed knowledge of the strain state and the resulting polarization is of crucial importance to the performance. In this project we try to extract the strain as a function of depth from 10 to 50 nm thin BST(001) films on SrTiO3(001) (STO).

Methods and Materials: The samples were grown using Laser ablation at a temperature of 800 C. We used both truncation rod diffraction and grazing incidence diffraction to access the out-of-plane and inplane lattice parameters as a function of depth.

Results: The Iscan around the BST(001) reflection shows a typical asymmetry together with an additional beating on the right side (see Fig.2). We modeled this beating using kinematical diffraction theory assuming a strain profile that is non-monotonic and exhibits a bump close to the interface. This bump originates from the strain field around the cores of misfit dislocations with a stand-off from the interface [1]. Fig. 1 shows the corresponding inplane contraction of the lattice at higher incident angles, i.e. close to the interface.

Conclusions: 100 Å thin films of BST on STO exhibit a peculiar strain profile perpendicular to the interface that results from misfit dislocation strain fields. These strain fields also manifest themselves in diffuse scattering around the film Bragg reflections. The modeling of the diffuse scattering (not shown here) is in agreement with the model for the CTR profiles.

Acknowledgments: We thank John Hill for his assistance with the beamline.

References: [1] H.-J. Gao et al., Appl. Phys. Lett. 75, 2524 (1999)

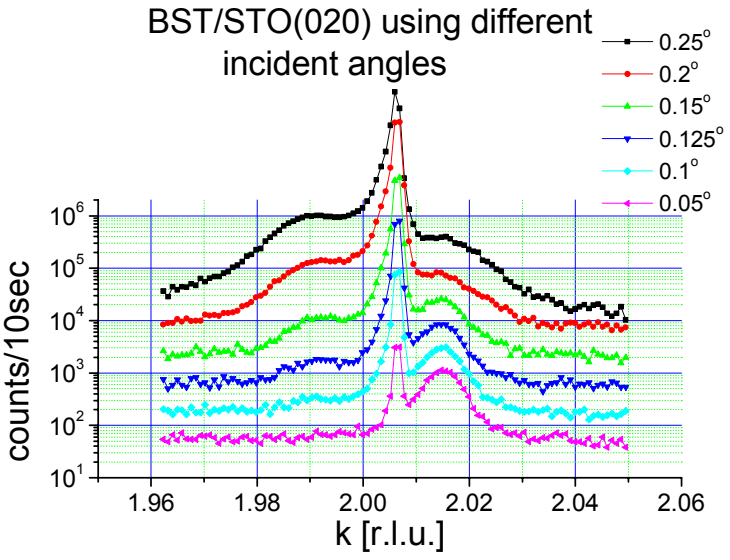

Figure 1. Inplane radial scan through the BST(020) reflection of a 100 Å BST/STO sample. The different incident angles correspond to different scattering depths

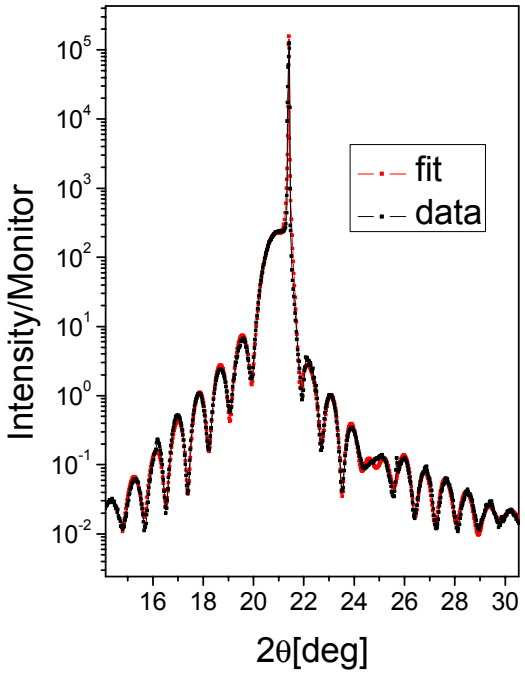

Figure 2. Iscan through the BST(001) reflection; the black line is a model calculation based on a non-monotonic strain profile resulting from misfit dislocations.